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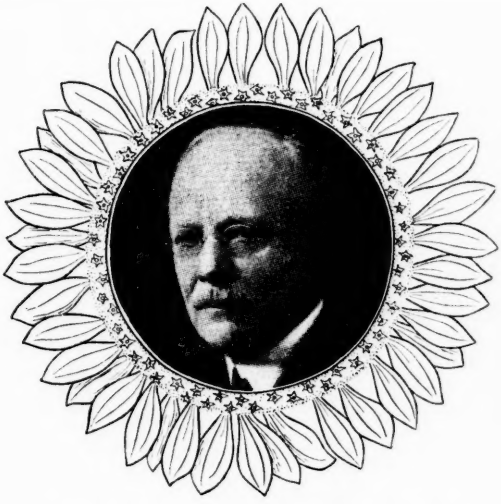

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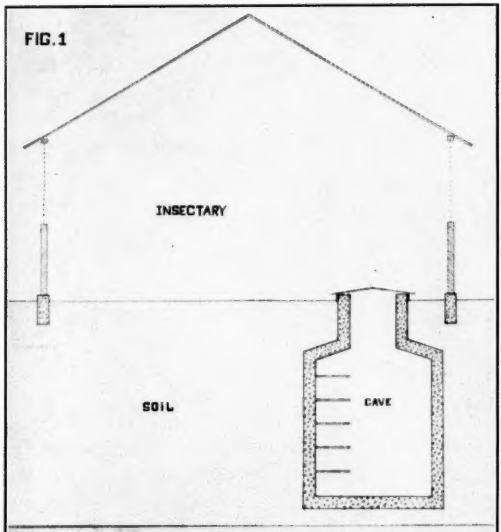
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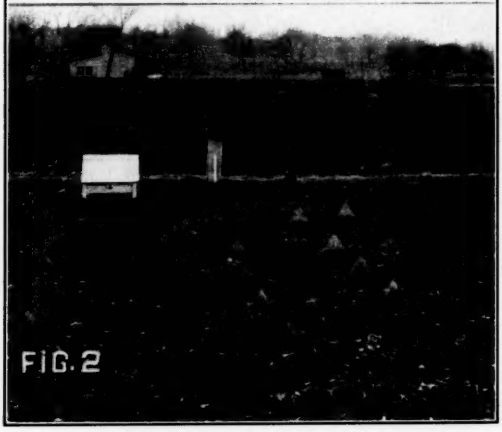
FIG.2

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TECHNIQUE FOR REARING SUBTERRANEAN INSECTS*

HARRY R. BRYSON**
Kansas Agricultural Experiment Station

Introduction

The problem of rearing insects which spend a portion or all stages of their life cycles beneath the surface of the soil is one of the most difficult tasks with which investigators in the field of economic entomology have to contend. Progress in the development of efficient control measures against underground insects has been retarded by the inability of investigators to secure accurate information concerning the habits, life stages and activities of many of these destructive pests.

Need for Improved Rearing Technique. The failure to secure accurate life history data is traceable in many instances to faulty rearing methods. Progress has been slow, due in part to the large number of species concerned, their diverse habits, and to the nature of the medium in which they live. The soil is a very complex medium when considered from its chemical, physical, biological and ecological aspects. Any attempt to study an insect, the habitat of which is the soil, results in a disturbance of the existing environmental complex and an unnatural response by the insect. Insects which live in a protected environment such as the soil affords are sensitive to even the slightest changes in the relationship which exists between them and the soil.

Investigators engaged in the problem of rearing soil insects should understand the fundamental principles underlying soil manipulation. Progress will be greatly retarded it the worker does not understand the properties of different soil types, soil structure and the inter-

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relationship which exists among the soil, insects and crop plants involved in his particular problem. A knowledge of these facts is also pertinent to successful interpretation of the micro-environment in which the insect lives and propagates its kind. The worker very early should solicit the cooperation of a good soil specialist to advise him in his problems concerning soil manipulation.

The fact that a number of the subterranean species require from 1 to 4 years or even more in which to complete their development also contributes to the complexity of the rearing procedure. Long life cycles are nearly always associated with high mortalities and this fact necessitates the utilization of large numbers of individuals. If it were necessary to carry 500 individuals through in order to obtain significant data on an insect which normally has two generations each season, or one generation in a year, an investigator working with subteranean insects which normally require three years in which to complete their life cycles, would be compelled to begin with at least 1500 individuals. If a mistake were made at the beginning of the investigation and not recognized until the second year, much time would be lost before the study could be repeated and the error corrected. At present much of the recorded information has been gained through the use of faulty or unnatural rearing conditions and should be rechecked as soon as suitable rearing technique has been devised.

Investigators of the life histories of soil insects are also confronted with the fact that the adults may reveal their activities, with the possible exception of oviposition, above the surface of the soil, while the phenomena relating to the changes in the egg stage or the activities of the larvae and the pupae occur beneath the surface. For example, the common white grub may be cutting off the roots of a blue grass sod, or girdling a choice aster plant ready to bloom, while the adult of the species is feeding at night on the leaves of a hawthorn tree in a nearby field. The food preferences of the adults, therefore, are not indicative of those of the larvae.

Workers familiar with the problems involved in the life-history studies of subterranean forms rarely appreciate the difficulties encountered in an effort to maintain the natural conditions of the separate environments of larva and adults. Spectacular results in as brief a period of time should not be expected as in the case of those

concerned with a species which has 4 generations in a single season and whose various stages are found in the same environment. The limited number of agricultural experiment stations which have projects dealing strictly with underground insects is evidence that the field is neither a spectacular one nor one that is likely to be overcrowded by seekers of short tenure projects.

Many of the statements found in textbooks regarding the length of the life cycles of wireworms are erroneous and should be corrected and brought up to date as soon as accurate information is available. The fact that a certain insect requires 3 years instead of 6 in which to complete its development is a very important one when considered from the standpoint of the agronomist interested in planning rotations for the purpose of controlling or preventing infestations of soil insects. The life cycles of some soil insects will be found to be much shorter once the proper rearing technique has been devised.

Nearly mature wireworms belonging to the genus Melanotus have been collected in the field and retained 8 years in ounce salve boxes containing moist soil. These larvae were fed sprouted wheat once every 10 days and the soil in the boxes changed at the time of feeding in the summer. The insects were not fed but the soil was changed once each month during the winter. The boxes were kept throughout the year in an underground cave where the temperature neither exceeded 80 degrees Fahrenheit in the summer nor dropped below 40 degrees F. during the winter.

White grubs reared under this artificial environment emerged as perfect specimens within the time which is now known to be correct, while the wireworms rarely matured and, if so, were usually abnormal. On the other hand, wireworms retained under similar conditions for 3, 4, 5, and 6 years matured the first year when removed to outdoor tile rearing cages planted to wheat.

General Equipment. Rearing conditions should be maintained which approximate as nearly as possible the natural environment in which the insect lives and reproduces. Certain equipment is necessary to reproduce and to measure the conditions of a natural environment.

It is practically impossible to rear wireworms, white grubs, false wireworms and root worms successfully without either a basement room, cellar or underground

cave in which to place receptacles containing insects which must be examined frequently for molts and measurements. A cool basement or underground field insectary is the ideal construction for handling young larvae during adverse weather. Such a room prevents not only the rapid desiccation of the larvae, but also retards the escape of moisture from the soil in the containers. During the summer of 1934, when the maximum daily temperatures at Manhattan reached 110 degrees to 115 degrees Fahrenheit for 11 consecutive days, the writers experienced great difficulty transferring newly hatched wireworms from one container to another without a high percentage of fatalities, though the larvae had been kept in a cave and were examined in a screened insectary.

Figure 1. Diagram showing arrangement of underground cave in relation to the field insectary.

Figure 2. Tile cages used in rearing wireworms.

An underground cave similar to one described by McColloch (11) (Fig. 1) proved a satisfactory place in which to keep the developing larvae, but did not possess ample working space. A recording soil-air thermograph and a standard rain gauge are desirable equipment for rearing studies of underground insects. A recording hygrothermograph, maximum-minimum thermometer should also be a part of all insectary apparatus. A steam sterilizer has been found useful in freeing soil of molds, nematodes, mites and insect larvae. Lard or garbage cans furnish ideal receptacles for retaining soil after sterilization when only small amounts are needed.

In addition to the foregoing list of general equipment, smaller apparatus such as a set of graduated soil sieves, soil acidity tester, simple hydrogen-ion apparatus, soil thermometers, soil auger and soil sample tins are conveniences not to be overlooked.

Progress in rearing subterranean insects also has been retarded because of the amount of labor and time which must be expended in handling soil. Lane (10), Shirck (17), Campbell (2), and coworkers have designed and constructed a power soil sifter which is mounted on a trailer attached to an automobile and transported to the field where the work is to be done. This relieves the investigator of the mechanical handling of the soil

and permits him to give his undivided attention to his observations and records.

Peterson (13) has illustrated some of the equipment now in use in the study of soil insects. Many of the cages which he illustrated for use in the study of insects above ground are applicable to rearing methods for underground insects.

Selection and Treatment of Soil. For the maintenance of the proper habitat of the insect to be reared, the soil requirement of the insect should be carefully studied to determine the type and structure in which it normally lives. In rearing wireworms, false wireworms, white grubs and root worms, the writer has found that the use of the soil normally inhabited by these insects is the most successful rearing medium for larvae.

To expedite the search for eggs and young larvae, the soil to be used in incubation and rearing cages should be sifted carefully to remove other insects, foreign matter, and to render the soil more uniform in composition. The soil then should be sterilized to kill soil mites, molds, fungi, nematodes, predacious invertebrates and the eggs of other soil organisms which pass through the sieve and later interfere with the accuracy of the observations and the development of the insect.

The writer has used steam with success while Campbell (2) and Stone (18) fumigated the soil in outdoor tile cages with carbon bisulphide before placing wireworms in them. This latter practice has not been followed at the Kansas Agricultural Experiment Station, but the procedure is an excellent precaution. Salve boxes in constant use should be exposed to the direct sunlight after being cleaned with steel wool.

A knowledge of the moisture content of the soil is essential to the successful rearing of subterranean insects because larvae have little opportunity to escape unsuitable moisture and temperature conditions so frequently provided in artificial rearing.

Food Requirements. The determination of the food requirements of larvae in early instars is frequently a perplexing problem. The unsterilized soil is often rich in micro-organisms and finely divided organic matter which may furnish food on which larvae in nature may exist until proper food conditions prevail. Wireworms in the later instars have been kept for a year or more in salve boxes containing soil alone.

Much experimental work needs to be done to ascertain the food habits of soil insects which are difficult to rear through the early instars. The lack of definite facts regarding the food habits at this stage is, in the writer's opinion, the greatest handicap to workers engaged in the study of subterranean insects.

While the foregoing discussion of general equipment and principles is applicable to rearing the majority of underground insects, the detailed procedure and equipment employed must of necessity vary with the habits and requirements of the species under observation. Since it is impossible within this brief space to describe the methods of rearing found successful for all subterranean insects, the discussion will be confined, for the most part, to the technique used in rearing white grubs, wireworms, false wireworms and the southern corn root worm.

The methods used at the Kansas Agricultural Experiment Station prior to 1928 have been described by McColloch (11) and Hayes (5), and were found adequate for rearing white grubs and false wireworms, but the writer (1) found the procedure unsatisfactory for wireworms (Elateridae) since it tended to lengthen their life cycles.

Methods for Obtaining Eggs. To rear larvae from eggs of known parentage, partially grown larvae or pupae may be collected in the field and reared to adults which must be accurately identified and retained for mating purposes, provided they emerge perfect specimens. Much time is sometimes lost in an attempt to maintain environmental conditions suitable for mating and oviposition. Lane (9) collected wireworms of the previous spring and confined them in soil cages. The writers ordinarily collected the adults when they first appeared in the summer or early spring and retained them for egg laying stock. This method was found the most expedient one when large numbers of eggs were desired.

Adults of **Diabrotica 12-punctata** Oliv., **Eleodes opaca** Say, **Eleodes tricostata** Say and click beetles of the genera Lacon, Monocrepedius, Aeolus, Melanotus and Hemicrepedius were easily induced to deposit eggs in one ounce salve boxes partially filled with moist, finely sifted soil. May beetles deposited eggs more readily in gallon tins containing moist soil, as described by Hayes (5). Lane (9) tamped the soil until firm in cages in which

click beetles were confined, while McDougall (12) confined Elateridae in 4-ounce glass jars filled two-thirds full of soil. Searls (16) kept females of **Diabrotica vittata** Fab. in a screen cylinder laid on its side on the surface of the soil beneath the cage.

Isely (7) placed adults of **Diabrotica 12-punctata** Oliv. in jelly glasses, in the bottom of which were salve can lids containing moist soil, while Robinson and Arant (14) kept beetles of the same species in glass vials 114 mm. high and 40 mm. in diameter supplied with a plug of damp cotton at the base of the vial. The writer found that these beetles also would deposit eggs in moist soil when kept in salve boxes or lantern globe cages and fed on alfalfa leaves. Click beetles retained by the writer in like containers and fed on honey remained alive for more than one month.

Separation of the Eggs from the Soil. Methods devised for removing the eggs from the soil are varied and involve considerable pains-taking labor. Those which do not involve the handling of soil eliminate the necessity of searching for the eggs, but the presence of soil appears to stimulate oviposition.

If accurate records are to be obtained, receptacles in which the adults are confined should be examined daily for the presence of eggs. When eggs are found, the soil containing them should be removed, the eggs counted, and the female returned to the container. The eggs may be separated from the soil by either sifting or washing. Lane (10) has found that a piece of fine mesh screen soldered into the rim of a pie tin with a removable bottom makes an excellent sifter for removing the eggs. Campbell (2), Stone (18), Shrick (17) and Lane (10) also use the washing method described by Shirck.

The eggs may be transferred individually from one container to another by means of a moistened camel's hair brush or a needle.

The writer has always used as incubation chambers, ounce salve boxes containing a mass of firm, moist soil. Small pits were made in the firmed surface to receive the eggs and to prevent them from rolling about when the boxes were examined. These containers then were transferred to an underground cave and inspected daily to determine the exact date of hatching. Incubation containers stored in an underground cave required no attention to maintain an adequate moisture supply. Lane (9) em-

phasized the importance of maintaining the soil moisture conditions similar to those in which the eggs were found in nature when he stated that the eggs of **Ludius noxus** Hyslop "should be handled under such humid conditions as would be normal at the same depth in the soil because they will not stand subterranean air conditions."

When wireworms hatched in the firmed soil, they burrowed into it immediately, hence did not come in such intimate contact with others hatching in the same box and thus the consequences of cannabalism were reduced to a minimum. In one instance, 540 larvae of **Hemicrepedius memnonius** were recovered from 565 eggs equally divided among five containers.

Care of Larvae. The writer has found that the young larvae of white grubs, southern corn root worms and false wireworms can withstand a lower soil moisture content at the same temperature than can larvae of Melanotus (Elateridae). McDougall stated that the critical point in rearing wireworms is in the early instars and that this crisis is further augmented by the fact that the requirements of early instars may vary considerably with different species.

The writer has had excellent success starting young wireworms in jelly glasses three-fourths filled with soil and transferring them later to outdoor tile rearing cages (Fig. 2). Ten larvae ordinarily were placed in each glass and allowed to remain approximately one month before being refed. Sprouted wheat was satisfactory food for rearing **Aeolus elegans** Say., white grubs and false wireworms, but did not prove adequate for **Melanotus communis** Gyll. and **Melanotus fissilis** Say. Kruger (8), who made an attempt to determine a food material which would produce the most rapid growth in the two species of Melanotus, recorded the following observations:

(1) Plain loam soil, raw carrot, honey, and crushed insect larvae did not sustain the young larvae.

(2) Larvae fed crushed cottonseed, powdered yeast and crushed ground beetles showed increasing growth in the order named.

(3) Larvae placed in soil in 6-inch drain tile and supplied with germinating grain, grew slowly at the start but their increase in growth was more continuous and with a lower mortality.

(4) The greatest and most rapid increase in growth was produced in larvae fed a combination of yeast and crushed beetles.

The results of this study, although preliminary in scope, indicated that young wireworms of the two species concerned were dependent upon food materials other than those found in sterile loam soil. Wireworms known to injure plants may at one or more stages require animal matter as a part of their diet. This theory is supported not only by the investigation just cited, but also by observations made in the field.

Melanotus larvae are not only cannibalistic in the early stages but have been observed to attack southern corn root worms, dipterous larvae, cutworms, small white grubs and dung beetle grubs. These observations and results of preliminary investigations suggest that some species which are believed to be herbivors may be reared more successfully if animal matter is added to their diets. Cannibalistic tendencies may be only a natural expression of a need for animal matter in connection with plant substances.

McDougall (12) was not successful in attempts to rear young wireworms between pieces of damp filter paper or in small pellets of soil between pieces of damp filter paper. Robinson and Arant (14) reared **Diabrotica 12-punctata** Oliv. in vials and maintained suitable moisture by the aid of moist cotton. Soil was added to the vial when the larvae reached the prepupal stage. Searls (16) reared larvae of **Diabrotica vittata** Fab. in petrie dishes in the bottoms of which were plaster of Paris plates. The roots of the food plant were spread out over the plate and covered with a piece of blotting paper saturated with a nutrient solution and then covered with a glass plate. Filinger (4), in his rearing studies of the garden Symphylid, **Scutigerella immaculata** Newport, used a muck plate made by mixing 10 parts of plaster of Paris with 3 parts of finely ground muck. The advantage of the muck plate and the plain plaster of Paris plate is that neither loses water rapidly. Light colored larvae are more easily seen on the muck plate.

Lane (10) and Shirck (17) reared wireworms successfully in galvanized iron cylinders 18 inches long and 12 inches in diameter. Davis (3) found large terra-cotta flower pots excellent cages for rearing white grubs when the pots were buried to the rim in the soil. Imms (6)

suggested the use of unglazed drain pipe as rearing cages when set vertically in the soil. Stone (18), Campbell (2) and the writer (1) found rearing cages made of two 6 inch unglazed drain tile, placed one on top of the other in the soil and covered with a screen cap, very successful for rearing wireworms.

Roberts (15) used glazed earthenware pots 5 inches by 15 inches, as well as salve cans, in rearing elaterid larvae. Other workers have with varying degrees of success, used containers and followed practices similar to the ones herein described. No doubt the manner in which the investigations were conducted was of more importance in insuring accurate results than the type of cages used.

Care of Pupae. Outdoor cages afford natural surroundings in which the larvae formed the pupal cells. These cells are constructed at depths where moisture and temperature conditions are suitable. Pupae of wireworms, false wireworms, white grubs, and cocoons of the parasitic wasps Elis and Tiphia retained indoors were placed in salve boxes containing soil. Slightly rounded cavities were made to receive the pupae, cocoons, or prepupae. When these were placed in a cellar or cave, the adults emerged without the addition of moisture to the containers. The pupae of southern corn root worms emerged more naturally when the pupal cells which they had formed remained unbroken. Stone (18) used a similar method in handling pupae of Elateridae.

SUMMARY AND CONCLUSIONS

1. Investigations in the field of subterranean insects have been retarded in their progress in the development of suitable rearing methods because of the number of species involved, their diverse habits, the extended life histories and the character of the medium in which they live. The labor required to maintain the conditions of separate environments for the adult and for each of the immature forms also proved handicaps difficult to overcome.
2. The general equipment necessary for successful rearing investigations should include an outdoor screen insectary, a cave, basement, soil-air thermographs, soil sifters, soil augers, Hydrogenion apparatus, rain guage, soil thermometers and rearing cages adapted to rearing the insect in question.

3. The investigator should possess a knowledge of the fundamental principles underlying soil manipulation or invite the cooperation of a soil specialist.

4. Soil is apparently the best medium in which to rear subterranean insects that require two or more years to complete their life cycles. Sterilization of the soil and containers is necessary to destroy mites, insect larvae, fungi, nematodes and other organisms which interfere with the accuracy of the rearing data.

5. The food requirements and the conditions of the environment suitable to the development of early instar larvae are still little understood in many species. Since the requirements of early instars vary with different species, each is a separate problem.

6. Rearing practices should be devised in an effort to provide natural environmental conditions for the egg, larval and pupal stages. This may best be done by studying the micro-environment in which these stages are found in the field.

7. The type of rearing cage to be used is apparently of less importance than the application of the investigator and the exactness with which he records and interprets his observations.

8. Progress in rearing subterranean insects is dependent upon the ability of experiment stations to maintain long tenure projects and to retain personnel satisfied with applying themselves diligently for a period of years without expecting immediate and spectacular results.

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ADDITIONS TO HEBARD'S LIST OF ORTHOPTERA OF SOUTH DAKOTA, WITH OBSERVATIONS ON SOME PREVIOUSLY RECORDED SPECIES.

H. C. SEVERIN, South Dakota State College.

In 1925 Morgan Hebard* published a paper on the Orthoptera of South Dakota. This paper was the first of a series of similar works, each being a report on the Orthoptera of a central or central western state.

Mr. Hebard's report on the Orthoptera of South Dakota was based almost entirely on collections of Orthoptera made by George Gilbertson and the author, of the Entomology-Zoology Department of South Dakota State College. The collections loaned Mr. Hebard consisted of approximately 9,000 specimens, which were taken from 67 different representative areas of South Dakota.

Hebard listed 149 species and races in his Orthoptera of South Dakota, of which 145 were classed as native, three as introduced and one species was classed as a tropical adventive. The regions or ranges occupied by these species or races in the United States are roughly indicated as follows: eastern; western; prairies and great plains, northeastern; northern; locally east and west; prairies, great plains and southwestern; prairies, great plains and northern Utah; great plains; prairies and great plains to Utah; northwest, great plains and prairies; southern great plains; northern great plains; great plains and southwestern; eastern, west to Montana; etc.

In summarizing the distribution of the South Dakota Orthoptera, Hebard writes as follows:

"Over half of these species are western, of which the majority are characteristic types of the Great Plains fauna. Of the balance, eleven occur in the northwest, six are generally distributed over the west, one is largely confined to the Rocky Mountains and one occurs in the southwest. It is becoming increasingly evident, however, that many of the forms, best known from the Great Plains, have a wide distribution over the high plains of the southwestern United States and northern Mexico. Twenty-two of the species here considered are found

*Hebard, Morgan. The Orthoptera of South Dakota. Proc. Acad. Nat. Sci. Phil. 77:33-155, 1925.

from the Atlantic to the Pacific, half being boreal forms. Two species only are peculiar to the prairies in the latitude of South Dakota and five reach this state from the south. The remaining thirty-nine eastern forms occur only in extreme eastern South Dakota, a number of them being confined to the southeastern corner."

In his paper on the Orthoptera of South Dakota, Hebard not only lists the species found in South Dakota but he also gives the reference to the original description of the species, also references to later literature which he believes most useful in identifying the species. He also discusses briefly the synonymy of each species. Further, he lists the area in South Dakota in which each species was taken, the duration of the appearance of the adults, the time of year when the adults occur in the greatest abundance, and, frequently, he discusses the habitat preferences of the species or races.

Since the appearance of Hebard's paper, extensive collections of Orthoptera were made in South Dakota by George Gilbertson and the author. More than a hundred thousand specimens were collected and the representative areas where collections were made were increased from an original 67 to more than 200. Naturally, the ranges of many of the Orthoptera reported were enlarged thru such extensive studies, but this phase of the work will not be discussed at the present time.

Thru this extensive work, an additional 13 species of Orthoptera, not listed in Hebard's paper, were found to occur in South Dakota. These species are enumerated hereafter. In connection with each species there will be listed the areas in South Dakota where the species was taken, the time of year when the adults were collected, and their habitat preferences.

Additional Species of Orthoptera Found in South Dakota

Blattidae

Blatta orientalis Linnaeus

Eureka XI, 30, 1927. 8♂, 9♀. 14 juv.
Madison XII, 6, 1933. 2♂.
XII, 12, 1933. 7♂, 8♀.
III, 16, 1935. 2♂.

This is a domiciliary pest that is undoubtedly established in many towns, especially in southeastern South Dakota.

Periplaneta americana (Linnaeus)

Yankton VI, 10, 1932. 2♂, 1♀.

This is another domiciliary pest, and while it has been taken only in one city in the state, it is sure to occur in other cities.

Acrididae

Acrydiinae

Boopedon nubilum (Say)

One hundred and ninety-three adult males and 172 adult females were taken from July 29 to September 16 in the following areas:

Orman Dam in Butte County
Wheeler Bridge in Charles Mix County
Chamberlain in Brule County
White River in Lyman County

A large number of nymphs in the second and third instars were taken at Wheeler Bridge in Charles Mix County on June 17, 1933.

The male and female specimens may be either long or short winged. Among the females, the long winged condition is comparatively scarce, for only 12 specimens out of 172 adults show this characteristic. The tegmina in such cases are broadly rounded distally and extend to the tip of the abdomen or nearly so. In the short winged females, on the other hand, the tips of the tegmina are usually pointed and ordinarily terminate before or slightly behind the middle of the abdomen. The males also are long or short winged, but the long winged condition seems to be more common, judging from the numbers of specimens in our collections. The tegmina of the short winged males are narrower than those of the long winged forms and usually end in front of the tip of the abdomen. The tegmina of the long winged specimens are broad and always are as long as or they reach beyond the end of the abdomen.

The bodies and tegmina of the male grasshoppers are all dusky black with but slight or minor differences in color between any two specimens. The females, however, present some striking color variants. Two color phases predominate, a brown and a black. The brown phase is more abundant than the black, but the black is by no means rare, for 60 out of 172 females in our collection are black. There is considerable color variation in

both the brown and black females, for a tinge of green often modifies the appearance of either phase considerably. Occasionally a specimen may be of a deep rich chocolate color instead of black. In many of the melanistic or black specimens, the color pattern of the brown phase is more or less faintly indicated.

Boopedon nubilum inhabits the great plains portion of South Dakota. It prefers certain species of tall grasses, growing especially in draws or coulees, but may be found on level ground. We have not found this species distributed generally over the plains area of South Dakota, but instead have found it locally, where at times it becomes quite abundant.

Bruneria brunnea (Thomas)

Two hundred and ten adult specimens were taken from August 30 to September 20 in the mountains of the Black Hills about 18 miles west of Custer in Custer County. These specimens were all collected from open grassy parks of the forested mountains, at an elevation of about 5,500 feet, where the species was common. The grasses, in general, were of the short types, but there were present occasional clumps of tall grass. Hebard reported that J. A. G. Rehn took two large and two small juvenile female specimens on Battle Mountain east of Hot Springs, at an elevation of 3750 to 4400 feet on July 21, 1909.

Oedipodinae

Trachyrhachis kiowi kiowi (Thomas)

This species of grasshopper varies wonderfully in the coloration of the head, pronotum, tegmina and caudal femora. However, there are two special color phases which are so striking that they were once upon a time designated distinct species, namely, Trachyrhachis pulchella (Bruner) and Trachyrhachis obliterata (Bruner).

In our collections there are 890 specimens of Trachyrhachis kiowi kiowi (Thomas). These were taken from practically every county of South Dakota, but the species is more abundant in the western two-thirds of the state.

Regarding T. pulchella (Bruner), Hebard* wrote as follows: "The type of pulchella in the author's col-

*Hebard, Morgan. The Orthoptera of South Dakota. Proc. Acad. Nat. Sci. Phil., 77:84, 1925.

lection and similar material before us, show plainly that this name was based merely on a striking chromatomorph of kiowi (in which the pale portions are greenish white and more extensive) unworthy of nominal recognition, which the describer found on sweet sage, Eurotia lanata Pursh."

There are 31 adult specimens of the pulchella color phase in our collections. These were taken by us from July 20 to September 12 in Harding, Butte, Lawrence, Pennington, Custer, Meade, Jackson and Dewey counties. These counties are all located in western South Dakota.

The coloration of the pulchella chromatomorph is quite variable, but in all specimens the color pattern typical of T. kiowi kiowi was maintained. In general, it is true that in pulchella specimens, a greenish white color replaced the pale markings of typical T. kiowi kiowi, but the extent of the greenish white color varied considerably. Further, shades of brown were substituted at times for the light green, especially on the pronotum.

Nymphs as young as the second instar were found with the typical pulchella coloration. Doubtless the pulchella coloration is fixed and determined thru heredity, but in our experience, this chromatomorph was found only in areas where light green lichens grew on the soil in considerable abundance. Whenever the grasshoppers rested on such lichens, the coloration of the lichens and grasshoppers harmonized so nicely that it became almost impossible to locate the grasshoppers unless they moved.

In our collections we found 28 specimens of T. kiowi kiowi with the wing disk distinctly tinged with yellow. In all other respects these did not differ from typical specimens of this same species. The dark wing band characteristic of T. kiowi thomasi was almost entirely obliterated in our specimens, only delicate traces of it remaining. It was upon specimens such as these but with a broad dark wing band that Bruner based his T. obliterata in 1906. We agree with Hebard that T. obliterata is not a valid species, nor should our specimens be given a varietal status, but they should be looked upon as specimens of T. kiowi kiowi that have acquired a yellowish wing disk. The 28 specimens under discussion were collected from 15 counties of the state, five of which are located west of the Missouri River and ten east. Specimens with the yellow wing disk and typical kiowi

occur together in the same environments, but the former are always comparatively scarce.

Cyrtacanthacrinae

Melanoplus foedus foedus Scudder.

Two hundred forty-eight adults were taken between June 21 and September 26, the majority during the latter part of July and during August and September. Areas in South Dakota where the species was taken were the following:

Buffalo in Harding County
Sand Hills near Buffalo in Harding County
Lead in Lawrence County
Philip in Haakon County
Martin in Bennett County
Sand Hills south of Martin in Bennett County
Parmalee in Todd County
Murdo in Jones County
Capa in Jones County
Little Bend in Sully County
Pierre in Hughes County
McNeeley in Tripp County
Mobridge in Walworth County
Chamberlain in Brule County
Hecla in Brown County
Lake City in Marshall County

This species varies greatly in size and color pattern. The external morphology resembles that of Melanoplus packardi Scudder so closely that it is impossible to separate these species without a study of the penis lobes.

Melanoplus foedus foedus is an inhabitant of both the prairies and plains, but in our experience prefers sandy areas. It has also been taken by us in sandy areas of the mountains of the Black Hills at an elevation of 5000 feet.

Melanoplus punctulatus punctulatus (Scudder)

Forty-four adults were taken in the wooded areas along the Missouri River about three to five miles south of Springfield, Bon Homme County, between August 26 and September 8.

This is an arboreal species and has been collected most frequently by us from the trunks and larger limbs of oak, ash, cottonwood and willow trees. Occasionally specimens were taken from plants beneath trees. The trunks or limbs of the trees from which specimens of this

grasshopper were taken were either living or dead and were more or less covered with lichens.

Tettigoniidae

Phaneropterinae

Conocephalus attenuatus (Scudder)

One adult male and one adult female were taken on August 26, 1929 near Wewela in Trip County. Both specimens were found in tall grasses growing on the banks of a small creek.

Decticinae

Anabrus simplex Haldeman

A total of 304 adults were taken between June 21 and September 30 near Philip in Haakon County, near Murdo in Jones County, and near Ree Heights in Hand County. Our first collections were made at Murdo and Ree Heights in 1931, when it was found that the species was abundant enough so that one individual, if he desired, could easily take 50 specimens in an hour. Since 1931, the writer has visited these same areas each year and always found the species in approximately the same numbers. However, this so-called Mormon cricket has not yet become abundant enough to cause any appreciable damage to crops in South Dakota.

In Haakon and Jones counties we found this insect most abundant in native grass land on the sides or bottoms of coulees. At Ree Heights, this cricket-like katydid was found most abundant in the native grass growing on the hilly moraines south of the town.

Steiroxys trilineatus (Thomas)

Two adult females were taken in the latter part of August, 1933, in the Black Hills about 15 miles west of Lead, near the South Dakota State line. Altho careful search was made in this and other neighboring areas, no additional specimens could be found. Our specimens were taken in rocky openings of a forested area where grass was short and fairly abundant.

Stenopelmatinae

Stenopelmatus fuscus Haldeman

Two adult males and three adult females were taken between October and November 1, and two immature males and two immature females were taken during July, all in the mountains eight miles northwest of Hot Springs. All of our specimens were found under boards, boxes or

logs lying on the ground.

Gryllidae

Gryllinae

Gryllus assimilis (color phase lineaticeps Stal.)

A total of 39 adult specimens were taken between June 15 and June 25 near Chamberlain in Brule County, near Pierre in Hughes County and near Hot Springs in Fall River County. All of these specimens had passed thru the winter undoubtedly as nymphs. The specimens were all collected in dry areas. Those at Pierre and Chamberlain were taken from cracks in grass-covered gumbo soil in coulees of the breaks near the Missouri River, while those taken near Hot Springs were found under stones lying on the banks of the Cheyenne River.

Typical specimens of Gryllus assimilis Fab. are black in South Dakota. The color phase, "lineaticeps," however is characterized by pale markings, the extent of which is exceedingly variable. The pale markings may be limited to the head in some specimens, while in others the area affected may extend over a portion or all of the mouth parts, over the thorax, abdomen, wings and legs. Those specimens having the pale markings extensively developed differ remarkably in coloration from the usual black type of common field cricket, not only because of the pale markings but also because those areas that are not pale in color are brownish.

Nemobiinae

Nemobius bruneri Hebard

Seven adult specimens have been taken by us thus far in South Dakota, four males and two females from near Elk Point in Union County and one female specimen from near Oacoma in Lyman County. These specimens were all taken on low wet land bordering the Missouri River between June 24 and September 7. None were macropterous.

Nemobius palustris Blatchley

Five adult male and nine adult female specimens were taken by us on September 14, 1925 near Springfield in Bon Homme County. All were collected from low wet bottom land located within two miles of the Missouri River. The particular area where this species was collected was located near a spring whose water flooded much of this particular habitat. None of the specimens collected were macropterous.

Gryllotalpinae

Gryllotalpa hexadactyla Perty

Sixteen specimens of this mole cricket were taken in South Dakota between August 11 and September 15. Of these, 10 specimens were taken in the Sand Hills eight miles south of Martin in Bennett County, two were taken under electric lights in the town of Martin, while two were taken under electric lights in the town of Gregory in Gregory County. Eight of the specimens in our collections were juveniles, while six were adults. Of the six that were adult, five were macropterous and four of these had been attracted to electric lights where they were captured.

The specimens which were not taken under electric lights were found by digging in sandy areas bordering creeks. Here they were found in burrows around the roots of plants or they were found in their superficial runways several feet from the roots of any plant.

While these insects are ordinarily subterranean in their habits, evidently they do come to the surface of the ground, at least when they are adult, and at such times they may, when macropterous, fly at least 8 to 10 miles to light.

Tridactylinae

Tridactylus apicalis Say

Five adult specimens of this cricket were taken by us in South Dakota. One was captured on June 21 and two specimens were taken on September 25, 1930 on the damp sand along the shoreline of a pond in the Sand Hills about ten miles south of Martin in Bennett County. The other two crickets were taken on August 19, 1927 in a sandy area bordering a spring-fed pond about five miles south of Springfield in Bon Homme County. All of our specimens were discovered leaping vigorously over the sand and none were found in pits or burrows.

Rhaphidophorinae

A report of the unrecorded species of Rhaphidophorinae taken by us in South Dakota will not be included in this paper, but will be deferred until T. H. Hubbell has the opportunity of publishing his revision of the genus Ceuthophilus.

HOST RELATIONSHIPS OF THE LARGER APPLE CURCULIO, TACHYPTERELLUS QUADRIGIBBUS MAGNUS LIST[1]

P. O. RITCHER, University of Wisconsin.

Introduction

Prior to 1932, only one species, **T. quadrigibbus** (Say), was generally recognized as belonging to the genus **Tachypterellus.** The species was considered very variable, and its range extended from the Atlantic to the Pacific, including parts of Canada. A second species, **T. consors,** was described by Dietz in 1891 from a single specimen taken in Oregon, but little subsequent mention had been made of it.

List, in 1932, after a study of material from 22 states and 4 points in Canada, concluded that four distinct forms exist, two of which represent **T. quadrigibbus** (Say) and **T. consors** Dietz, and two of which he described as **T. quadrigibbus magnus** List and **T. consors cerasi** List.

This paper deals with variations within the subspecies **T. quadrigibbus magnus** List as it occurs on wild and cultivated hosts growing in the Kickapoo Valley apple district of Wisconsin.

Relation of Host to Adult Size

A great amount of variation in the size of individual apple curculios was found as a result of collecting material in 1934 at Gays Mills, Wisconsin, from wild hosts such as **Crataegus** and **Pyrus** and from cultivated apple. This was thought at first to be due to the presence of a hybrid population consisting of both **T. quadrigibbus,** the eastern form, and **T. quadrigibbus magnus,** western form, which List suggested might occur in the middle west.

Rearing work and systematic collections made in 1935 show that a great deal of the size variation in Gays Mills material is correlated with the hosts in which the curculios developed. Curculios reared from **Crataegus** and curculios taken on **Crataegus** shortly after the emergence of the new generation began are, in general, much smaller in size than those reared from cultivated apple or taken on apple at the corresponding time (Table I).

A study of Table I which is based on material secured between July 13 and August 11, 1935, shows that

1—Published with the permission of the Director of the Wisconsin Agricultural Experiment Station.

there is but slight overlap between the size ranges of the curculios from the two hosts. **Crataegus** is by far the most common wild host of the apple curculio in Western Wisconsin. Thus it would seem possible to estimate the amount of transfer between wild and cultivated hosts, for any one year, simply by measuring and comparing collections taken from the two hosts during the spring feeding and egg laying period.

Such a comparison is made in Table II which represents collections made on wild and cultivated hosts from May 14 to July 2, 1935. It will be seen that while the spring male curculio population on apple, in general, has the same body length range as that of reared material or material collected on apple in mid-summer, as shown in Table I, three of the 16 males are outside the ordinary size range of male curculios from apple. These fall well within the range of the summer **Crataegus** population. On the other hand, seven of the 42 males taken on **Crataegus** are above the ordinary range of the summer male **Crataegus** population.

Only one female curculio from apple is outside the ordinary range for females from apple. It falls well within the ordinary range of **Crataegus** females. Only 5 of the 62 females from **Crataegus** are outside the ordinary range of females from apple.

TABLE I. Effect of Host Upon Size of Apple Curculios

MALES

Body length in mm.	Reared from apple	Taken on apple	Reared from Crataegus	Taken on Crataegus
1.9-2.1				
2.2-2.4			1	2
2.5-2.7			1	7
2.8-3.0			2	16
3.1-3 3	1			8
3.4-3.6	2	4	4	4
3.7-3 9	9	5	2	
4.0-4.2	25	13		
4.3-4.5	21	30		
4 6-4.8	8	29		
4.9-5.1	3	2		
5.2-5.4		1		
5.5-5.7				

FEMALES

Body length in mm.	Reared from apple	Taken on apple	Reared from Crataegus	Taken on Crataegus
1.9-2.1				1
2.2-2.4			1	
2.5-2.7				1
2.8-3.0			1	7
3.1-3.3			5	11
3.4-3.6	3		2	13
3.7-3.9			4	7
4.0-4.2	2	2	4	2
4.3-4.5	8	6	1	1
4.6-4.8	11	22		
4.9-5.1	32	34		
5.2-5.4	4	13		
5.5-5.7		9		

TABLE II.

Comparison of Spring Apple
Curculio Populations on Apple and Crataegus

Body length in mm.	Males		Females	
	Taken on Apple	Taken on Crataegus	Taken on Apple	Taken on Crataegus
2.2-2.4				
2.5-2.7		2		
2.8-3.0	3	8		5
3.1-3.3		5	1	14
3.4-3.6		12		17
3.7-3.9	1	7		14
4.0-4.2	6	4	3	4
4.3-4.5	4	3	3	3
4.6-4.8	1		8	3
4.9-5.1	1		5	2
5.2-5.4			2	
5.5-5.7			2	

It appears from these figures that the transfer of curculois from **Crataegus** to apple and from apple to

Crataegus was in each case approximately ten percent. Since the amount of transfer from wild to cultivated hosts was small and since there was crossover in both directions, it would seem that the removal of wild hosts, often recommended as a control measure, would be of little or no value. This is especially true when one considers that the **Crataegus** apple curculio population serves as a breeding ground for parasites and that the immediate result of wild host destruction might be to force the usual **Crataegus** curculio population over to cultivated apple.

Factors Discouraging Cross-Over

Because the amount of transfer in nature is small, between wild and cultivated hosts, one might assume the existence of two subspecies of curculios. This seems untrue since the apple curculio of the cultivated apple is a native pest which has come over from wild hosts within the last century, Riley, 1871. Furthermore, the writer has found that small curculios, morphologically identical with the usual **Crataegus** population, are readily produced in **Crataegus** from eggs laid there by large curculios reared from apple. [1]

It is probable that the small size of curculios produced in **Crataegus** is due to the small amount of food usually available. On **Crataegus** the curculio larvae often feeds within but a single carpel while in the apple the whole ovary, including two or more fully developed carpels and sometimes part of the flesh, in addition, is consumed.

Several additional observations substantiate this hypothesis. Small adult curculios from apple were secured by taking partly developed larvae from apple fruits and giving them no further food. Small adults were also produced in apple drops under other abnormal conditions such as excessive moisture in rearing glasses. On the other hand, it was possible to secure good sized

1—It has not been demonstrated that eggs laid in apple fruits by small curculios from **Crataegus** will produce large individuals typical of the normal apple population. Because of the small number of eggs deposited in apple fruits by small curculios from **Crataegus**, only two adults, both females, were secured. Both of these were similar to their parents in size. This point will be further investigated.

curculios from **Crataegus,** if exceptionally large fruits were kept moist.

It would thus seem that an explanation other than the existence of separate subspecies must be sought. As a result of feeding experiments and observations made during the past two years, the writer believes that feeding and egg laying preferences, plus the sluggish nature of the insects combine to keep transfer at a minimum.

Although feeding tests were carried on in both 1934 and 1935, only certain of the 1935 experiments, which were definitely planned to settle this point, are used. In these experiments the large apple curculios used were bred from apple the previous season and overwintered in a screen wire cage under a McIntosh tree. The curculios from **Crataegus** were part of a lot of 28 individuals obtained early in May, 1935, from an aster cloth cage placed over a sawed off clump of **Crataegus.**

Six pairs of curculios from **Crataegus** and four pairs of curculios from apple, from the sources mentioned above, were confined in individual jelly glasses and given a choice of **Crataegus** fruits or apple fruits for feeding and oviposition. The fruits were removed daily and fresh material supplied throughout the season. The curculios from **Crataegus** showed strong feeding and oviposition preferences for **Crataegus.** Curculios from apple showed strong feeding and oviposition preferences for apple. Tables 3 and 4.

The sluggishness of the apple curculio is a second factor that discourages the cross-over between wild and cultivated hosts. Curculio infestation occurs in the same sections of the same orchards year after year and individual trees continue to be heavily or lightly infested.

The new generation is produced mainly in drop fruits but in the case of some varieties, such as Ben Davis, a considerable percentage issue from undersize fruit left on the spurs. New individuals feed actively for a short time, usually not longer than two weeks, and then go into hibernating quarters which Hammer (1933) has shown to be under apple trees. As for the hibernation quarters of the **Crataegus** curculios, the writer took 28 of them, all small, from beneath a clump of **Crataegus** not over 30 yards from two large orchards.

TABLE III.

Oviposition and Feeding Preferences of Apple Curculios from Crataegus

Pair	Crataegus		Apple	
	Eggs laid	Total Punctures	Eggs laid	Total Punctures
No. 1	46	269	12	136
No. 2	30	307	13	99
No. 3	28	240	3	76
No. 4	2	138	0	19
No. 5	32	247	1	36
No. 7	22	158	0	33

TABLE IV.

Oviposition and Feeding Preferences of Apple Curculios from Apple

Pair	Eggs laid	Total Punctures	Eggs laid	Total punctures
No. F	5	115	93	287
No. G	1	132	71	352
No. H	2	197	74	330
No. I	5	112	52	143

Summary

Larger apple curculios occurring in western Wisconsin vary greatly in size. This is due in large part to the fact that **Crataegus** produces small and cultivated apple large curculios. There is much less transfer between the two hosts than might be expected. This is thought to result from feeding and egg laying preferences and the sluggishness of the curculios.

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A NEW HORSEFLY FROM THE SOUTHEASTERN UNITED STATES

CORNELIUS B. PHILIP, Hamilton, Montana.

Among specimens of Tabanidae collected by Professor R. H. Beamer and others in the region of the Okefenokee Swamp in Georgia and 2 points in Florida were 14 flies representing an apparently undescribed species. A similar specimen from North Carolina has been in the collection of the writer for a number of years, placed doubtfully with **Tabanus fronto** O. S., and this additional series confirms its distinctness.

T. subfronto n. sp. Female—length 13-15 mm. Like **fronto** but the body, in general, lighter red without the prominent dark and pale abdominal bands, and smaller. Antennae, palpi, legs (except fore tarsi) and venter of abdomen essentially concolorous, light reddish.

Head with front rather broad, sides parallel, the callosity fulvous, subquadrate or slightly narrowed, with narrow extension above; antennae much as in **fronto** but paler red, the apical annulus dark; palpi elongate, bluntly rounded apically, the black hairs sparse and not obscuring the ground color. Thorax marked as in **fronto** but paler on the pleurae and pectus, the upper pleural pile below the wing base without blackish hairs seen in that species. Wings suffused and with prominent clouds, hardly as pronounced as in **fronto** and cell R5 strongly coarctate at the margin. Legs, including the vestiture, reddish (occasionally the hairs of the fore femora a deeper rufous and those of the 2 hind pairs yellowish). **Abdomen** rather slender, shining reddish or tan colored, the indistinct, narrow, buff, posterior borders with obscure lateral expansions and with a mesal row of prominent, light yellowish, rather blunt triangles (a dark spot at the apex of the triangle on the second tergite sometimes evident). Venter pale red, unbanded, although the incisures may be narrowly yellowish. Eye pattern (relaxed) consists of 2 narrow green crossbands on a purple ground, united outwardly.

Holotype—14 mm. Raleigh, N. Car. Aug. 7, 1903, C. S. Brimley. In the collection of the author.

Paratype females. Seven Okefenokee Swamp, Ga., July 30 and August 3, 1934, P. A. McKinstry or R. H. Beamer; 2 Folkston, Ga., August 2, 1934, J. D. Beamer; one Hilliard, Ga., Aug. 19, 1934, R. H. Beamer; 3 ft.

Pierce, Fla., Aug. 7, 1930, R. H. Beamer; one Fruitvilla, Fla., Aug. 11, 1930, A. D. Tuthill; and one Mimsville, Ga., Aug. 20, 1905. In the collections of the University of Kansas, the U. S. National Museum, and the author. Compared with 10 **T. fronto** from Ga. and Fla.

The concolorous, light reddish appendages and yellowish frontal callosity will distinguish it from **fronto** O. S., and the reddish front femora and paler callosity from **trijunctus** Wlk. It is smaller than either and lacks the blackish, upper pleural pile and the contrasting banded appearance of the abdomen, while the front appears a little narrower and the third antennal segment chunkier, a little less elongate between the dorso-basal prominence and the annuli compared to **fronto.** Osten Sacken states in his original description of **fronto,** "Length 17-18 mm.; some specimens much smaller" which may indicate that some **subfronto** were also before him although the description does not bear this out.

THE MALE OF NOTONECTA ARABIENSIS HUNGERFORD (NOTONECTIDAE, HEMIPTERA)

H. B. HUNGERFORD, Lawrence, Kansas

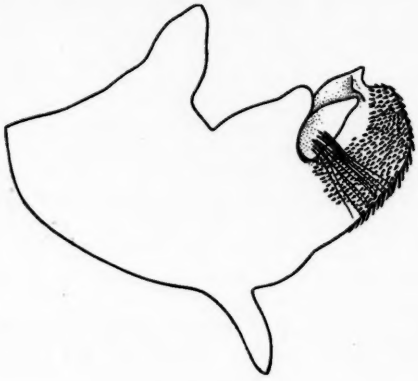
This large red and black species was described* from two female specimens found in the British Museum and labeled "Arabia". Recently I received from Doctor A. Kiritshenko of Leningrad, U. S. S. R. a gift of some insects in which I was delighted to find a male and female of **N. arabiensis.** These were labeled "Sonoa, Jemen 2x'31" and correctly determined by Doctor Kiritshenko. The "Jemen" is undoubtedly Yemen in the southwest of Arabia and gives us more precise knowledge of where to look for this species.

The female received compares very well with the paratype before me. The male is a trifle more slender and possesses a few more black maculations on the hemelytra; the anterior trochanter is provided with a small dentation. The genital capsule is shown in the figure.

*Annals of the Entomological Society of America, Vol. XIX, p. 280, 1926.

**University of Kansas Science Bulletin, Vol. XXI, 1934.

The lobe behind the clasper is quite distinctive. The digitate prolongation of the male capsule assigns the species to the subgenus Notonecta. In my paper on the Notonecta of the World** I placed this species in its proper place although no males were then known. I am designating the male from Sonoa, Yemen as the allotype of **Notonecta arabiensis** Hungerford.



AN UNUSUAL RECORD IN LEPIDOPTERA

A Nymphalid butterfly collected in the fall of 1935 at Wellington, Kansas, by Richard Titus, has been identified as **Chlosyne** (or **Synchloe**) **lacinia** race **adjutrix** Scudder, by Mr. Frank E. Watson of the American Museum of Natural History. **Lacinia** is a polymorphic species in which a number of races have been described. The race **adjutrix** has hitherto been known from northeastern Mexico and southern Texas, and the above record is therefore a considerable extension of its known range.

CURTIS W. SABROSKY, Michigan State College.

ADDITIONS TO OUR KNOWLEDGE OF THE BIOLOGY OF PELIDNOTA PUNCTATA LINN. (SCARABAEIDAE- COLEOPTERA).

CLARENCE H. HOFFMANN, Morristown, New Jersey

While searching for **Trichiotinus** larvae in decayed stumps in Kansas during January and March of 1933, approximately 80 larvae of **Pelidnota punctata** Linn. were taken in Douglas, Jefferson, and Wyandotte counties. Upon my return to Minnesota, these larvae were isolated in four-ounce salve boxes, which were supplied with small pieces of decayed wood, and kept in a basement room at about 25 degrees C. Each box was checked every other day, and fresh food as well as a few drops of water were added if needed. Sixty out of the 80 larvae attained the pupal stage and of this number 45 were permitted to complete their development unmolested. Heretofore this species has been considered difficult to rear by the salve box method in the laboratory.

Habitat.—Adults of this species are most commonly found feeding on grapes, both wild and cultivated. The grubs develop in rotten wood, and during this study they were collected from elm, sycamore, and walnut stumps. Most of the grubs were inhabiting the elm, and as many as 25 were removed from the roots of a single stump. Occasionally grubs of this species were found feeding in the center of old stumps, but the majority had hollowed out tunnels in the large lateral roots which were six to eight inches below the surface of the soil. Such roots were quite moist and exceedingly tough to cut, thus making it difficult to extricate the grubs without injury.

Egg Stage.—According to Hayes (1925), the eggs of **P. punctata** are pearly white in color, elongate-oval in shape, and when freshly laid are about 2 mm. long and 1.5 mm. wide. Later they become larger and more spherical. He also observed that the average duration of the egg stage based on 979 eggs was 14.9 days, with extremes of 8 and 26 days.

Larval Stage.—This species overwinters either as a first or a second-year grub in deteriorated stumps and logs. Most of the grubs collected in the field were subsequently reared on decayed elm wood. Some, however, were supplied with different kinds of rotten wood from time to time. Such changes as walnut to birch to oak,

elm to birch to cherry, and elm to oak to cherry, apparently did not adversely affect the development of the grubs, because their size and duration of larval life were within the limits exhibited by grubs reared entirely on elm.

Hayes (1925) observed that the duration of the first stadium for 12 individuals was 71.5 days (range 54 to 87 days); the duration of the second stadium, if it occurred the same season, for 5 individuals was 13.6 days (range 8 to 22 days); and the duration of the second stadium, if it occurred the following year, for 7 individuals was 289 days (range 277 to 316 days). My records show that 5 grubs collected in January molted the following spring and summer. Undoubtedly this was the delayed second molt, therefore, the average duration of the third stadium was 390 days (minimum 337, maximum 441 days).

Prepupal Stage.—Shortly before becoming prepupae, the larvae constructed roomy cocoons out of small fragments of wood. As the mature larvae approached prepupation they became much shortened and less mobile, whereas after entering this stage they seldom moved unless disturbed. The prepupae of this species measured about 30.5 mm. in length and 10.5 mm. at their greatest width. The length of the prepupal stage varied from 3 to 10 days, with an average of 6.1 days for 59 individuals kept under observation.

Pupal Stage.—Pupation occurred within the prepupal cast in the cocoon. The pupae, which averaged about 22 mm. long by 11 mm. wide, were entirely white when freshly emerged, but soon attained a predominantly brown color. The mean duration of the pupal period based on 46 individuals was 21. 8 days, range 16 to 27 days.

Adult Stage.—Of the 60 pupae reared from larvae collected in the field, 41 were males and 19 females. Thus, the males were twice as abundant as the females as revealed by the rearing of larvae collected at random. Oviposition may occur throughout the summer months; the eggs being laid singly in moist soil beneath suitable logs or near decayed stumps. Adults of this species have a longevity of about 30 days as indicated by 30 individuals kept under laboratory conditions. The present study confirms the observations made by Dr. Hayes show-

ing that the life cycle of **P. punctata** requires two years.

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A NEW POBLICIA FROM TEXAS (HOMOPTERA-FULGORIDAE)

P. W. OMAN, Bureau of Entomology and Plant Quarantine
United States Department of Agriculture.

So far as is known the genus **Poblicia** is limited in distribution to tropical and subtropical America, and only the following three species are known to occur north of Mexico: **P. fuliginosa** Olivier, which has a wide distribution in the southern part of the United States and parts of adjacent Mexico west to Arizona; **P. walkeri**[1], recorded from our territory by Metcalf[2] under the name of **constellata** Walker; and **P. texana,** herein described. The specimens upon which Metcalf's record was based appear to represent an extreme variation of **walkeri,** but may prove to be distinct when more material is available for examination. Records of **misella** Stal from north of Mexico undoubtedly are based on pale examples of **fuliginosa; misella** appears to be a valid species separable from **fuliginosa** by its small size. Ball[3] has pointed out that **thanatophana** Kirkaldy is a synonym of **fuliginosa** Olivier.

Poblicia texana, n. sp.

Related to **fuliginosa,** and resembling pale specimens of that species in general color, but larger, with a longer head, and with the fore femora not at all expanded distally. Measurements of male: Length of body, 13 mm.; length, with wings, 18.5 mm.; expanse, 35 mm.; greatest width of pronotum, 5 mm.

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1 **P. walkeri** is here proposed as a new name for **Polocera constellata** Walker, 1858, not **Lystra (Polocera) constellata** Guerin-Meneville, 1856.

2 Jour. Elisha Mitchell Sci. Soc., vol. 38, p. 149, pl. 38, fig. 9, 1923,

3 Psyche, vol. 40, p. 146, 1933.

General color pale sordid testaceous, with a broad, median fuscous stripe across head and thorax. Median carina of pronotum and scutellum pale, dividing median fuscous stripe. Crown and scutellum with fuscous spots laterad of median stripe; head and thorax above sometimes tinged with olivaceous green. Longitudinal veins of fore wing, except distally, pale green; cross-veins and veins of distal portion usually yellowish brown or testaceous. Costal margin of fore wing pale. Hind wing fuscous subhyaline; membranes at base of wings tinged with pink. Dorsum of abdomen fuscous basally, the fuscous area extending back to 6th segment on median line; remainder red.

Crown of about uniform length throughout its width, anterior margin distinctly turned upward, median carina irregular. Head narrower than thorax. Front visible anteriorly beyond crown, transversely subcarinate just below transverse sulcus and again near base of clypeus. The usual median and oblique frontal carinae present but not prominent. Portion of front laterad of oblique carinae not extended as far upward as median portion, leaving a quadrangular area below crown margin at each end of transverse sulcus. Clypeus subcarinate medially. Anterior margin of pronotum subtruncate on median third, only slightly sinuated behind eyes and extending in a nearly straight line from median portion to humeral angles. Surface of crown, pronotum, and scutellum with numerous fine, mostly transverse rugae except on median longitudinal carina. Fore wing subcoriaceous, coarsely reticulated basally, distal portion with numerous weak cross-veins; hind wing with numerous weak cross-veins in distal portion and with vannal area coarsely reticulated. Venter of abdomen, portions of thorax, and legs, especially the basal segments, set with numerous fine, hairlike setae.

Male plates larger than in either **fuliginosa** or **constellata,** but with basal hooks much shorter and blunter. Dorsal margins of plates much thickened, posterior margins rounded in lateral view.

Holotype male from Dallas, Texas, Sept. 21, George M. Greene. Paratypes, 1 male from Brazos Co., Texas, April 11, 1922, R. K. Fletcher, and 1 male from Paris, Texas, Oct. 8, 1904, on cedar, C. R. Jones. Types in collection of the United States National Museum, Cat. No.

51616.

This species may be easily separated from both **fuliginosa** and **constellata** by the transverse carinae on the front and the quadrangular areas at each end of the transverse sulcus, as well as by the genital characters mentioned. The color is quite distinctive but may be expected to vary considerably. In certain structural features, such as the carinate clypeus and front, **texana** approaches the genus **Domita** Stal, but **Domita,** based on the insular forms **basistella** Walk. and **constellata** Guer. which apparently represent but a single species, has the fore wings much more finely reticulated, the head narrower, and the crown extending upward in a flange-like projection above each eye laterally. **Poblicia** and **Domita** are very closely related and doubtfully distinct.

DISTRIBUTIONAL NOTES ON UTAH COLEOPTERA:(1) PART II (2)

GEORGE F. KNOWLTON

Family **Carabidae**

Cychrus hemphilli Horn. Logan Canyon, Utah, May 17, 1933 (Knowlton).(3)

Calosoma triste Lec. Ft. Duchesne, July 11, 1932 (F. K. Stoffers).

Callisthenes utensis Csy. Lampo, April 1, 1933.

Platynus placidus (Say). Duchesne, April 27, 1933.

Harpalus caliginosus (Fab.). Beaver Dam. April 7, 1933; Madsen: Penrose (M. J. Janes).

H. amputalus Say. Fruitland, April 28, 1933; Snowville.

H. stocktonensis Csy. **Cheirinia repanda** at Timpie, June 14, 1932.

H. lecontei Csy. Copperton, April 6, 1933; Honeyville.

H. oblongus Csy. Blue Creek, May 31, 1932; Promotory; Snowville.

Family **Haliplidae**

Peltodytes callosus (Lec.). Grantsville, April 12,

(1) Contribution from the Entomology Department, Utah Agricultural Experiment Station.

(2) Continued from: Jour. Kansas Ent. Soc. 7: 79-86 (1934)

(3) Unless otherwise indicated, locality is in Utah, and collections since 1922 made by the writer.

Publication Authorized, 9 January, 1936.

1930; Lehi.

Family **Silphidae**

Necrophorus obscurus Kby. Logan, April 7, 1931 (W. L. Thomas); Strawberry (E. W. Anthon)

N. guttulus Mots. Far West, September 15, 1932 (L. Cutler); Provo (W. W. Henderson).

N. guttulus sub. sp. **hecate** Bland. Ft. Duchesne, July 26, 1927 (W. Sorenson); Logan (Thomas); Strawberry (Anthon).

N. defodiens Mann. Logan, May 12, 1931.

N. tomentosus Web. Benson, July 23, 1909 (E. G. Titus); Logan, November 12, 1930 (Thomas).

N. marginatus Fabr. Clearfield, June 25, 1927; Ft. Duchesne (Stoffers); Logan, (J. H. Linford); Providence (Janes); Salt Lake City; Springville (Anthon); Saratoga; Trenton (D. M. Hammond); Vineyard.

Silpha lapponica Hbst. Ephraim; Ft. Duchesne. July 8, 1932 (Stoffers); Heber; Locomotive Springs; Logan; Providence; Snowville; Strawberry (Anthon); Tooele; Wellsville.

S. ramosa Say. Bountiful, September 2, 1929 (H. J. Pack); Corrine; Ephraim; Farmington (Janes); Ft. Duchesne (Cutler); Logan; Roy; Santaquin; Strawberry (Anthon).

S. bituberosa Lec. Grantsville, June 20, 1927; Hooper (Pack); Ogden.

Family **Orthoperidae**

Orthoperus scutellaris (Lec.). Logan, May 30, 1933 (T. O. Thatcher).

Family **Staphylinidae**

Platystethus americanus Er. Holden, June 25, 1933.

Stenus rigidus Csy. Mendon, July 16, 1907 (Titus). Also Whitney, Idaho August 1, 1907 (Titus).

Paederus neveadensis Aust. American Fork, August 17, 1903.

Lathrobiella oregonensis Csy. Logan, May 30, 1933 (Thatcher).

Gyrohypnus obsidianus (Melsh). Bountiful, May 12, 1929 (Pack); Logan (Thatcher).

G. hamatus (Say). Logan.

Philonthus aeneus (Rossi). Heber, June 11, 1933; Logan (Thomas); Strawberry (Anthon).

P. agilis (Grav.). Providence, October 19, 1930 (Janes).

(Continued in Vol. 9, No. 4).

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